

## section 2 Acceleration

### What You'll Learn

- what acceleration is
- to predict how acceleration affects motion

### ● Before You Read

Have you ever been in a foot race? What kinds of things are measured in a foot race?

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### ● Read to Learn

#### Acceleration and Motion

Have you ever seen a rocket launch? When the rocket first lifts off, it seems to move very slowly. But very soon the rocket is moving at a fast speed. How can you describe the change in the rocket's motion? When an object changes its motion, it is accelerating. **Acceleration** is the change in velocity divided by the time it takes for the change to happen.

#### How is speeding up acceleration?

When you first get on a bike, it is not moving. When you start pedaling, the bike moves faster and faster. This is acceleration. An object that is already moving can accelerate too. Imagine you are biking along a level path. When you start to pedal harder, your speed increases. When the speed of an object increases, the object is accelerating.

#### How is slowing down acceleration?

Suppose you are biking at a speed of 4 m/s. If you brake, you will slow down. It might sound odd, but when you slow down you are accelerating. Any change in velocity is acceleration. Acceleration happens when an object speeds up or slows down.

When an object is speeding up, its acceleration is in the same direction as its motion. When an object is slowing down, its acceleration is in the opposite direction of its motion.

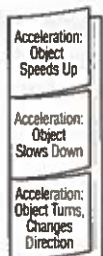
#### Study Coach

**Outline** Create an outline of this section as you read. Be sure to include main ideas, vocabulary terms, and other important information.



#### FOLDABLES™

**B Classify** Make the following three-tab Foldable to help you classify and understand the different types of acceleration.



## How is changing direction acceleration?

Remember that acceleration is a change in velocity. A change in velocity can be a change in speed, direction, or both. So, when an object changes direction, it accelerates. Think of yourself on a bicycle. If you lean to one side and turn the handlebars that direction, you turn. The direction of the bike's motion changes, so the bike accelerates. The acceleration is in the direction the bike turns.

Imagine throwing a ball straight up into the air. The ball starts out moving upward. After a while the ball stops moving upward and begins to come back down. The ball has changed its direction of motion. The ball is now accelerating downward.

## Calculating Acceleration

If an object is moving in a straight line, its acceleration can be calculated with this equation.

$$\text{acceleration (m/s}^2\text{)} = \frac{\text{final speed (m/s)} - \text{initial speed (m/s)}}{\text{time (seconds)}}$$

$$a = \frac{(s_f - s_i)}{t}$$

In this equation, time is the length of time it takes for the motion to change. Initial speed is the starting speed. Acceleration has units of meters per second squared ( $\text{m/s}^2$ ).

## What are positive and negative acceleration?

Suppose you are riding your bike in a straight line. You speed up from 2 m/s to 8 m/s in 6 seconds.

$$\begin{aligned} a &= \frac{(s_f - s_i)}{t} \\ &= \frac{(8 \text{ m/s} - 2 \text{ m/s})}{6\text{s}} = \frac{6 \text{ m/s}}{6\text{s}} = +1 \text{ m/s}^2 \end{aligned}$$

So your acceleration is  $+1 \text{ m/s}^2$ . Now suppose you slow down from 8 m/s to 2 m/s in 6 s.

$$\begin{aligned} a &= \frac{(s_f - s_i)}{t} \\ &= \frac{(2 \text{ m/s} - 8 \text{ m/s})}{6\text{s}} = \frac{-6 \text{ m/s}}{6\text{s}} = -1 \text{ m/s}^2 \end{aligned}$$

Your acceleration is  $-1 \text{ m/s}^2$ .



## Think it Over

1. **Explain** how an object accelerates when it changes direction.

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## Applying Math

2. **Calculate** A sports car accelerates from zero to 28 m/s in 4 seconds. What is its acceleration?

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**✓ Reading Check**

3. **Identify** What type of acceleration do you have if you are slowing down?

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**What does negative acceleration mean?**

When you speed up, your acceleration is positive. When you slow down, your acceleration is negative. That is because when you slow down, your final speed is less than your initial speed. This gives you a negative value in the equation and a negative acceleration. ✓

**How do you graph accelerated motion?**

You can show the motion of an accelerating object on a graph. For this type of graph, speed is plotted on the vertical axis. Time is plotted on the horizontal axis. The graph below is an example.

**Positive Acceleration** In section A of the graph, speed increases from 0 m/s to 10 m/s during the first 2 seconds. Acceleration is  $5 \text{ m/s}^2$ . An object that is speeding up will have a line that slopes up on a speed-time graph.

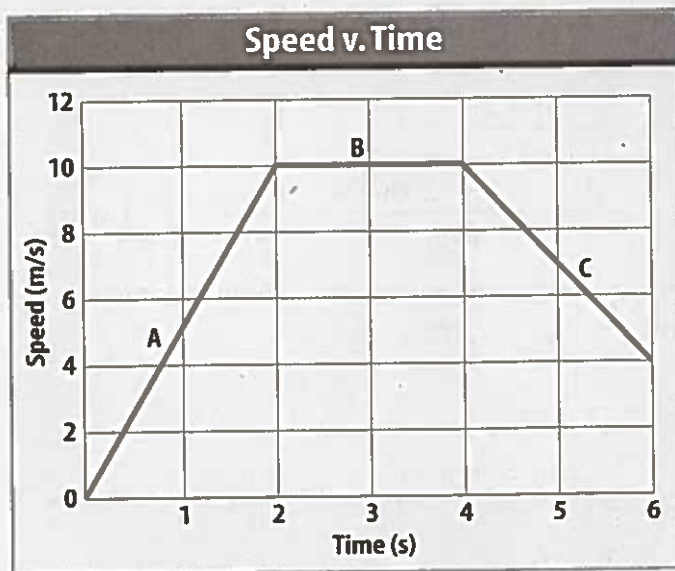
**Zero Acceleration** In section B of the graph, the speed does not change. If speed does not change, the object is not accelerating. A horizontal line on a speed-time graph means zero acceleration.

**Negative Acceleration** In section C of the graph, the object goes from 10 m/s to 4 m/s in 2 s. Acceleration is  $-3 \text{ m/s}^2$ . You can see that the line on the graph slopes downward as an object slows down.

**Picture This**

4. **Interpret Data** For how many seconds does the object in the speed-time graph have an acceleration of zero?

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## ● After You Read

### Mini Glossary

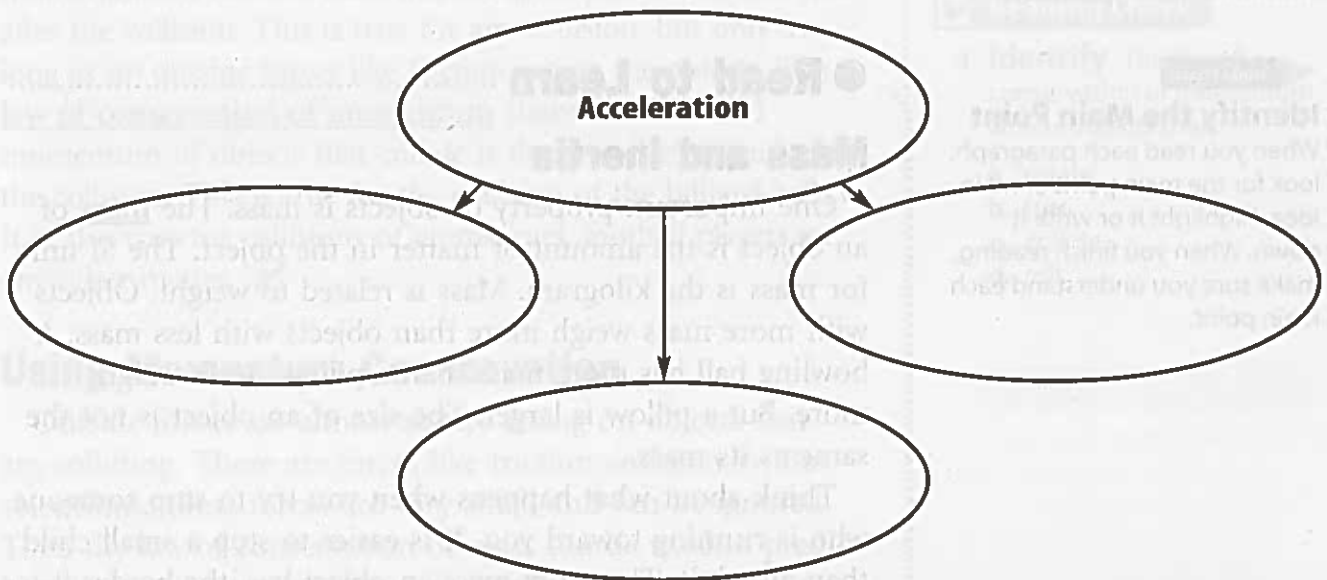
**acceleration:** the change in velocity divided by the time it takes for the change to happen; occurs when an object speeds up, slows down, or turns

1. Review the term and its definition in the Mini Glossary. Describe the term *acceleration* in your own words.

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2. Fill in the chart with the different ways an object can accelerate.



3. Why do you think that slowing down is sometimes called deceleration instead of acceleration?

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